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Alaska Department of Fish and Game
Division of Commercial Fisheries
P.O. Box 3-2000
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Origins of Chinook Salmon in the Yukon River Fisheries, 1988

by

John A. Wilcock

State of Alaska

Steve Cowper, Governor

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AUTHOR

John A. Wilcock is Yukon River salmon stock identification project leader for the Alaska Department of Fish and Game, Division of Commercial Fisheries, 333 Raspberry Road, Anchorage, AK 99518.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

Analysis of scale patterns and age composition of chinook salmon (*Oncorhynchus tshawytscha* Walbaum) from Yukon River escapements in Alaska and commercial fishery catches in Canada were used to construct run-of-origin classification models for lower Yukon River Districts 1, 2, and 3 commercial and subsistence harvest. Linear discriminant models were used to estimate stock composition for age-1.3, -1.4, and -1.5 fish. Discriminant models and observed age composition differences among escapements were used to estimate run of origin for other age groups. Run of origin for all other drainage harvests was estimated primarily from geographic occurrence. Total Yukon River harvest was 168,757 chinook salmon of which 61.3% was estimated to be the Upper Yukon Run, 11.4% the Middle Yukon Run, and 27.4% the Lower Yukon Run. The fraction of the Districts 1 and 2 commercial catch composed of the Lower Yukon Run generally increased through time, while the fraction composed of the Upper Yukon Run generally declined. The middle run component fluctuated somewhat through the season. The contribution of the Middle Yukon Run was the second lowest ever estimated.

KEY WORDS: Chinook salmon, *Oncorhynchus tshawytscha*, stock separation, catch and run composition, linear discriminant analysis, Yukon River

INTRODUCTION

Yukon River chinook salmon (*Oncorhynchus tshawytscha* Walbaum) are harvested in a wide range of fisheries in both marine and fresh waters. During their ocean residence, they are harvested in salmon gill net fisheries in the North Pacific Ocean and Bering Sea and as an incidental catch in trawl fisheries in the Bering Sea (Meyers and Rogers 1985). Within the Yukon River returning adults are harvested in commercial and subsistence fisheries in both Alaska and Canada (Figures 1 and 2).

In the first 20 years after statehood (1960-1979), the combined Alaskan and Canadian Yukon River chinook salmon commercial and subsistence harvest averaged 122,971 fish annually (ADF&G 1988). Beginning in 1980 annual harvests increased substantially. During the recent 5 years (1984 through 1988) yearly commercial and subsistence catches together averaged 184,602 fish. While chinook salmon are harvested virtually throughout the entire length of the Yukon River, the majority of the catch has been taken in commercial gill net fisheries in Districts 1 and 2 (1984-88 average 60% of total drainage harvest). Subsistence harvests throughout the drainage, including Canadian catches, account for another 29% (1984-88 average) of the total harvest. Most the subsistence harvest is taken with fish wheels and gill nets in Districts 4, 5, and 6. In 1988, commercial and subsistence fishermen in Alaska and Canada harvested a total of 168,757 chinook salmon, of which 92,297 fish (54.7%) were taken by District 1 and 2 commercial fishermen (ADF&G 1988).

Chinook salmon harvested in the Yukon River fisheries consist of a mixture of stocks destined for spawning areas throughout the Yukon River drainage. Although more than 100 spawning streams have been documented (Barton 1984), aerial surveys of chinook salmon escapements indicate that the largest concentrations of spawners occur in three distinct geographic regions: (1) tributary streams that drain the Andreafsky Hills and Kaltag Mountains between river miles 100 and 500; (2) Tanana River tributaries between river miles 800 and 1,100; and (3) tributary streams that drain the Pelly and Big Salmon Mountains between river miles 1,300 and 1,800. Chinook salmon stocks within these geographic regions were collectively termed runs by McBride and Marshall (1983) and are now referred to as the Lower, Middle, and Upper Yukon Runs, respectively. Pending future study of spawner distribution, the Lower-Middle Run boundary has not yet been precisely resolved. A major controversy currently facing managers of Yukon River chinook salmon is allocation of the harvest among competing user groups. Two such allocation issues which have recently received considerable attention are: (1) high seas interceptions of North American chinook salmon (including fish destined for the Yukon River) in the gill net and trawl fisheries in the North Pacific Ocean and Bering Sea; and (2) negotiations between the United States and Canada over inriver harvest of chinook salmon destined for the Canadian portion of the Yukon River drainage. Thus, an increasingly important facet of Yukon River chinook salmon management is identification of the fisheries in which Yukon River stocks are harvested.

Harvest estimates of Western Alaskan/Canadian Yukon chinook salmon in the Japanese high seas gill net fisheries (Rogers et al. 1984; Meyers et al. 1984; Meyers and Rogers 1985), have become major elements in the regulation of these ocean fisheries. Similarly, stock composition of inriver fisheries has been studied to provide useful information for inriver allocation decisions and to improve management precision through a better understanding of spatial and temporal migratory patterns of Yukon stocks. Stock composition estimates of the catch through time for Yukon River chinook salmon became available in 1980 and 1981 with the initial investigation of scale patterns analysis in District 1 (McBride and Marshall 1983). Since then, harvest proportions by geographic region of origin have been estimated annually for the entire drainage (Wilcock and McBride 1983; Wilcock 1984, 1985, 1986; Merritt et al. 1988; Merritt 1988).

The objective of this study was to classify the 1988 Yukon River chinook salmon commercial and subsistence harvest to the run of origin.

METHODS

Age Determination

Scale samples provided age information for fish in the catch and escapement. Scales were collected from the left side of the fish approximately two rows above the lateral line in an area transected by a diagonal from the posterior insertion of the dorsal fin to the anterior insertion of the anal fin (Clutter and Whitesel 1956). Scales were mounted on gummed cards and impressions made in cellulose acetate. Ages are reported in European notation.

Catch Sampling

Scales were collected from commercial catches in Districts 1, 2, 4, 5, and 6, and in Yukon Territory, Canada. Subsistence catches in Ditricts 4, 5, and 6 were also sampled. District 3 was not sampled because few fish are harvested in that portion of the Yukon River and access is difficult. A small fraction of the District 2 catch can at times include District 3 catches delivered in District 2. Subsistence fishing in Districts 1 and 2 occurred concurrently with commercial fishing, and the age composition of the subsistence catch was assumed to be similar to the commercial catch. Samples were also collected from a test gill net fishery in District 1 and from test fish wheels used to capture fish for a mark and recapture project in Yukon Territory. Sampling of Alaskan fisheries was conducted by the Alaska Department of Fish and Game (ADF&G). Division of Commercial Fisheries, while Canadian fishery and test fish wheel samples were collected by the Canadian Department of Fisheries and Oceans (DFO).

Escapement Sampling

Scale samples were collected during peak spawner mortality from the Andreafsky, Anvik, Nulato, Gisasa, Chena, and Salcha Rivers in Alaska, and from the Big Salmon, Little Salmon, Nisutlin, Tatchun, Takhini, Ross, and mainstem Yukon Rivers in Canada. Samples were primarily collected from carcasses. However, some samples were obtained from live fish captured with spears, gill nets, snagging gear, or direct current electroshocker for a separate genetic stock identification study conducted by the U.S. Fish and Wildlife Service (USFWS).

The age composition of Lower, Middle, and Upper Yukon Runs was estimated by weighting the age composition calculated for the individual spawning tributaries in each area by the escapement to each tributary as indexed by aerial surveys or mark/recapture spawning population estimates. Those tributaries which were sampled but for which no abundance estimate was available were not included.

Estimation of Catch Composition

Linear discriminant function analysis (Fisher 1936) of scale patterns data and observed differences in age composition between escapements were used to estimate 1988 Yukon River chinook salmon catches by their run of origin.

Scale Patterns Analysis

Escapement samples in Alaska and commercial fishery samples in Canada provided scales of known origin that were used to build linear discriminant functions (LDF). Scales representing the Lower Yukon Run were selected from samples collected on the Andreafsky, Anvik, Nulato, and Gisasa Rivers. The Middle Yukon Run was represented by scales from the Chena and Salcha Rivers. Canadian escapement samples could not be pooled to form a reasonable standard because of the lack of samples from several substantial spawning populations. Therefore, the Upper Yukon Run was represented with samples from the commercial fishery near Dawson.

Scales from the lower river commercial gill net fishery catch samples were classified to run of origin using the discriminant functions. Run proportions of fish aged 1.3, 1.4, and 1.5 were estimated for District 1 and 2 catches by fishing period for periods with adequate samples sizes. For periods with inadequate sample sizes, the proportions from periods close in time with the same mesh size restrictions in effect were used to estimate catch by run.

Measurements of scale features were made as described by McBride and Marshall (1983). Scale images were projected at 100X magnification using equipment similar to that described by Ryan and Christie (1976). Measurements taken along an axis located at the approximate apex of circuli formations in the freshwater growth zone were recorded by a microcomputer-controlled digitizing system.

The apex of circuli formations tends to differ between growth zones and consistency of axis placement was deemed most likely to occur if the apex of circuli in the freshwater zone served as the axis indicator. The distance between each circulus in each of three scale growth zones (Figure 3) was recorded. The three zones were: (1) scale focus to the outside edge of the freshwater annulus (first freshwater annulus zone), (2) outside edge of the freshwater annulus to the last circulus of freshwater growth (freshwater plus growth zone), and (3) the last circulus of the freshwater plus growth zone to the outer edge of the first ocean annulus (first marine annular zone). In addition, the total width of successive scale patterns zones was also measured for: (1) the last circulus of the first ocean annulus to the last circulus of the second ocean annulus, and (2) the last circulus of the second ocean annulus to the last circulus of the third ocean annulus. Seventy-nine scale characters (Appendix A) were calculated from the basic incremental distances and circuli counts. Run-of-origin standards (pooled rivers) were weighted by aerial abundance estimates for the Lower Yukon Run and by spawning population estimates from mark/recapture studies on the Chena and Salcha Rivers for the Middle Yukon Run. As in all previous years except 1987, run-of-origin models were constructed for age-1.3 and -1.4 fish. In addition, models were also constructed for the first time for age-1.5 fish as this age class comprised 28.2% of total drainage harvest in 1988.

Selection of scale characters for linear discriminant functions was by a forward stepping procedure using partial F-statistics as the criteria for entry and deletion of variables (Enslein et al. 1977). A nearly unbiased estimate of classification accuracy for each LDF was determined using a leaving-one-out procedure (Lachenbruch 1967).

Contribution rates for age-1.3, -1.4, and -1.5 fish in the District 1 and 2 catches were estimated for each fishing period. Point estimates were adjusted for misclassification errors using a constrained maximum likelihood procedure described by Hoenig and Heisey (1987) which does not require construction of models with fewer standards when one or more standards are not present in mixed stock samples. Variance and 90% confidence intervals were approximated using an infinitesimal jackknife procedure described by Millar (1987). This method of estimating variance accounts for variation in the mixed stock sample, but does not account for the variation of the classification matrix. It has been demonstrated that the two sources of error are additive and future methods for estimating variance may include both sources. Although confidence intervals are probably underestimated by this present method, it was used over previous methods to take advantage of the considerable analytical efficiencies of the constrained maximum likelihood classification procedure.

Results of the age-specific scale patterns analysis by fishing period were summed to estimate total contribution by run of origin for age-1.3, -1.4, and -1.5 chinook salmon to the District 1 and 2 commercial catches.

Age Composition Ratio Analysis

Classification of the remaining age classes in the District 1 and 2 commercial catches by run of origin was based on escapement age composition ratios. An assumption implicit in this calculation is that fisheries did not differentially harvest stocks or age groups. This assumption may have been violated, but any bias introduced was believed to be minor. Escapement age composition data, weighted by aerial survey estimates, was used to compute ratios for each run by dividing the proportion in the escapement of the age class in question by the proportion in the escapement of an age class where the catch composition was estimated by scale patterns analysis (age 1.3, 1.4, or 1.5):

$$R_{cia} = E_{ci}/E_{ca} \tag{1}$$

where:

E_{ci} = Proportion of fish of age i in run c escapement samples where i was an age class of unknown run composition in the catch

E_{ca} = Proportion of fish of age class a in run c where a was an age class of known run composition in the catch (age 1.3, 1.4, or 1.5)

Because the proportions of age-1.1, -1.2, and -2.2 fish in escapement samples collected in previous years have tended to decrease as the distance upriver increased, proportions for these age classes were divided by the proportion of age -1.3 fish. Proportions of age-2.4, -1.6, and -2.5 fish were divided by the proportion of age-1.5 fish as these ages have historically increased with distance upriver. Proportions of age-2.3 fish were divided by the proportion of age-1.4 fish because both ages were of the same brood year and both increased in upriver escapements. These ratios of proportional abundance were then multiplied by the estimated catch by run of age-1.3, -1.4, or -1.5 fish. These computations were summed over all runs to calculate age-specific contribution rates. Multiplying the age-specific ratio by the catch of the age class indexed in the denominator of the ratio yielded age-specific run contribution estimates:

$$F_{ci} = \frac{R_{cia} \cdot N_{ca}}{\sum_{j=1}^{n} R_{ji} \cdot N_{ja}} \qquad (2)$$

where:

j = Lower, Middle, or Upper Yukon Run

n = 3

N_{ca} = Catch of age group a (where a was either age 1.3, 1.4, or 1.5) in run c

F_{ci} = Proportion of fish of run c in N_i

The total harvest of run c for age group i was then:

$$N_{ci} = F_{ci} \cdot N_i \qquad (3)$$

where:

N_i = Total catch of age group i

Estimation of Catch Composition by Fishery

Estimates of run composition from scale pattern analysis and differential age composition analysis of District 1 and 2 commercial catches were used to classify the catches of subsistence fisheries in Districts 1 and 2 as well as commercial and subsistence fisheries in District 3.

District 4 catches were divided into two components for purposes of estimating catch proportions by stock: (1) commercial and subsistence catches from the mainstem Yukon River, and 2) subsistence catches from the Koyukuk River. Estimation of catch composition for District 4 was complicated by a number of conditions relating to the availability of catch samples and the number of stocks potentially present in District 4 catches. District 4 is over 350 miles long, and only a portion of the Lower Yukon Run tributaries (Anvik, Nulato, and Gisasa Rivers) contribute to District 4 harvests. Of these tributaries, Anvik River fish contribute only to catches within a few miles of the downstream end of District 4, while Nulato and Gisasa River fish contribute only to catches in the lower half of District 4. All scale samples from District 4 mainstem catches in 1988 were collected upstream of the Anvik River; a large portion of these samples were collected from catches above the confluence of the Koyukuk River, which was assumed to be the upstream boundary of Lower Yukon Run stocks in the mainstem Yukon River. Boundaries between Lower and Middle Yukon Runs have not been precisely established, pending further examination of spawning distribution. However, chinook salmon spawning in the Melozitna and Tozitna Rivers, averaging from 100 to 300 aerial survey counts for both streams totaled, are the only documented spawning concentrations between the uppermost Lower Yukon Run streams sampled (Nulato and Gisasa Rivers) and Middle Yukon Run escapements in the Tanana River drainage (Chena and Salcha Rivers). Because of these problems, the available catch samples were felt to inadequately represent contributions by stock in District 4 mainstream commercial and subsistence harvests. Contribution rates were estimated by applying the 1984-87 average contributions by age class to the season total harvest from both fisheries (including both gill net and fish wheel gear type). Previous contribution estimates (1984-87) were based on scale pattern analysis of age-1.3 and -1.4 fish and differential age composition analysis of remaining age groups (Wilcock 1985 and 1986; Merritt et al. 1988; and Merritt 1988).

Subsistence catches from the Koyukuk River were taken primarily in the upper portions of the drainage beyond river mile 700. Scales collected from the upper Koyukuk River drainage during 1986 resembled scales from the Middle and Upper Yukon Runs (Merritt et al. 1988). Because the Koyukuk River drainage lies entirely within Alaska, Koyukuk River subsistence catches were assumed to be entirely Middle Yukon Run. The age composition of the Koyukuk River subsistence catch (484 fish) was assumed to be similar to the age composition of District 4 mainstem catches.

Catch Composition Based on Geographical Segregation

Subsistence harvests in District 5, District 6, and Yukon Territory, were classified to run of origin based on geographical segregation. The entire District 5 harvest was assumed to be from the Upper Yukon Run. This assumption was made because most of the District 5 catch occurred above the confluence of the Tanana River, and aerial survey counts of chinook salmon spawning in the Porcupine and Chandalar River drainages, totaling less than 100 fish for each year since 1980, are the only documented chinook salmon spawning concentrations between the Tanana River confluence and the Yukon Territory fishery centered in Dawson. The entire District 6 harvest was considered to be from the Middle Yukon Run, since neither Lower nor Upper Yukon Runs are present in the Tanana River. The Yukon Territory harvest was assigned to the upper run since neither lower nor middle runs are present in Yukon Territory.

RESULTS AND DISCUSSION

Age Composition

Yukon River chinook salmon escapement age compositions in 1988 exhibited a variety of trends and contrasts (Table 1). Similar to all other years sampled, increasing proportions of older fish were noted in escapements moving progressively upriver. Age 1.4, the generally predominant age class of Yukon River chinook returns, was relatively weak in 1988, as was the age 1.3 return from the same brood year (1982) in 1987. The proportion of age-1.4 fish were the lowest recorded in Lower Yukon Run escapements since 1982, and were the lowest proportions ever observed for Upper Yukon Run escapements. In contrast, the contribution of age-1.5 fish to escapements was high, as was the contribution of age-1.4 fish from the same brood year (1981) in 1987. The proportions of 7-year-old fish (primarily age 1.5) observed in Upper Yukon Run escapements exceeded proportions of 6-year-old fish (primarily age 1.4) for almost all rivers sampled. Age-1.3 fish comprised the largest proportion of escapement samples for Lower Yukon Run. As in all previous years, the greatest proportions of age-2. fish were found in Upper Yukon Run samples. An unusually high escapement contribution (65.6%) of age-2. fish was observed for the Takhini River, a large lake-fed stream in Canada sampled for the first time in 1988.

Classification Accuracies of Run of Origin Models

Mean classification accuracies of 3-way, run-of-origin models for both age-1.3 and -1.4 fish (64.5% and 65.7%) were relatively low (Table 2). Although these results were slightly lower than most previous studies, they still represent probabilities of correct classification roughly twice that of random chance. Mean classification accuracy of the age-1.5 model was 71.1%, slightly higher than the average of 70.1% for age-1.3 and -1.4 models from all previous years (1980-87). Similar to past years the lower river standard showed the greatest classification accuracies (83.7%, 75.0%, and 95.7% for ages 1.3, 1.4, and 1.5, respectively). Upper river standards yielded the lowest classification accuracies (47.6%, 49.2%, and 48.9% for age 1.3, 1.4, and 1.5, respectively), misclassifying primarily as Middle Yukon Run. High misclassification between middle and upper river standards have been observed every year since initiation of the Yukon River chinook salmon stock identification study in 1980.

Catch Composition

Scale Patterns Analysis

The scale measurement characters which were most powerful in distinguishing between the three runs of origin were: (1) the freshwater annular zone divided by the total width of freshwater growth zones and (2) the width of the freshwater annular zone (Appendix B). Secondarily selected variables were derived primarily from measurements within the first annular zone or were variables combining features of the freshwater annular and plus growth zones. Measurements of marine growth provided relatively little discrimination in all models. Group means and their standard errors for the number of circuli and width of the first freshwater annular, plus growth, and marine annular zones are shown in Appendix C.

Proportion of Catch

Upper and Lower Yukon fish comprised the largest proportions of District 1 and 2 commercial harvest of age-1.3, -1.4, and -1.5 chinook salmon in 1988 (Tables 3 and 4). Run contribution estimates through time for age-1.3 and -1.4 fish in

District 1 catches were variable (Figures 4 and 5). Age-1.5 fish in both district catches were predominantly Upper Yukon Run throughout the season.

Upper Yukon fish predominated age-1.3 catches during the earlier portion of the season in District 1 (particularly during unrestricted mesh fishing), while Lower Yukon fish predominated during restricted mesh fishing of the summer chum season. Middle Yukon fish were low in abundance throughout the season.

Age-1.4 catches in District 1 were predominantly composer of Lower Yukon fish through the season. Upper Yukon age-1.4 fish declined to very low levels after 20 June, while the proportion of the Middle Yukon Run peaked late in June.

Age-1.5 comprised over 25% of the commercial harvest in both Districts 1 and 2 during 1988. The Upper Yukon Run dominated catches of this age class during all periods sampled in both districts. This observed predominance of the Upper Yukon Run in age 1.5 commercial catches was consistent with observed age composition differences among escapements to the three runs.

The estimated District 1 catch of age-1.3, -1.4, and -1.5 fish combined was 16,623 (36.1%) Lower, 4,651 (10.1%) Middle, and 24,771 (53.8%) Upper Yukon Run (Table 5). The relative contribution of Lower Yukon fish for the three ages combined in the District 1 catch tended to increase through time, while the contribution of Upper Yukon Run tended to decrease. Contribution of Middle Yukon Run was variable. In District 2 the estimated age-1.3, -1.4, and -1.5 combined catch was 8,977 (31.8%) Lower, 2,819 (10.0%) Middle, and 16,461 (58.3%) Upper Yukon Run (Table 6).

A total of 74,297 age-1.3, -1.4, and -1.5 fish (44.0% of total drainage utilization) from District 1 and 2 commercial catches were directly classified to run of origin based on results of scale patterns analysis (SPA). An additional 11,298 fish (6.7% of total drainage utilization) from District 1, 2, and 3 subsistence and District 3 commercial harvests were also classified to run of origin by applying season total SPA results to individual district season totals by age class (Table 7).

Differential Age Composition Analysis

The remaining age classes (not age 1.3, 1.4, or 1.5) from Districts 1 and 2 commercial catches contributed 18,000 fish (10.7%) to the total drainage harvest. They were classified to run of origin using differences in escapement age composition in each run (Table 7). The majority of age-1.2 fish harvested (11,817 or 75.5%) in District 1 and 2 commercial catches were Lower Yukon Run. Virtually all age-2. fish were classified to the Upper Yukon Run.

Geographical Analysis

A total of 50,113 fish (29.7% of total drainage harvest) were classified to run of origin based on geographical segregation. District 5 and Yukon Territory commercial and subsistence catches (25.7% of total drainage harvest) were assumed to be Upper Yukon fish. Commercial and subsistence catches in District 6 and subsistence catches from the Koyukuk River in District 4 (Table 7) were classified entirely to the Middle Yukon Run and totaled 6,687 fish (4.0% of total drainage harvest.

Total Harvest

The commercial and subsistence harvest of chinook salmon from the entire Yukon River drainage was classified to run of origin (Table 7) based on: (1) findings of the scale patterns analysis of age-1.3, -1.4, and -1.5 fish in District 1 and 2 commercial catches, (2) age composition analysis of the remaining age classes, (3) assumptions concerning unsampled fisheries, and (4) stock origins based on geographical segregation. The Upper Yukon Run comprised the largest run component and contributed 103,421 fish or 61.3% of the total drainage harvest. The Lower Yukon Run was next in abundance at 46,161 fish (27.4%), followed by the Middle Yukon Run at 19,183 fish (11.4%).

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TABLES AND FIGURES

Table 1. Age composition of Yukon River chinook salmon escapement samples, 1988.

			Brood Year and Age Group									
	Escapement Index Abundance	Sample	1985	1984	1983		1982		1981		1980	
Location	Estimate	Size[a]	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5
Lower Yukon												
Andreafsky River	2,787[b]	403[c]	0.2	27.8	29.5	0.0	26.8	0.0	15.6	0.0	0.0	0.0
Anvik River	1,805	246[d]	0.0	30.5	37.8	0.4	27.2	0.0	3.7	0.4	0.0	0.0
Nulato River	1,775	123[e]	0.0	14.6	59.3	0.0	18.7	0.8	5.7	0.0	0.8	0.0
Gisasa River	797	175[e]	1.1	29.7	41.1	0.6	21.7	0.0	5.1	0.6	0.0	0.0
Middle Yukon												
Chena River	3,045[f]	468[g]	0.6	10.5	17.5	0.0	46.4	0.0	24.6	0.0	0.0	0.4
Salcha River	4,562[h]	497[g]	0.4	20.3	22.3	0.2	42.1	0.0	14.5	0.2	0.0	0.0
Canada (Upper Yukon)												
Ross River	202	123	0.0	2.4	12.2	0.0	26.0	0.0	59.3	0.0	0.0	0.0
Mainstem Yukon R.	[i]	51	0.0	5.9	25.5	2.0	29.4	0.0	37.3	0.0	0.0	0.0
Tatchun Creek	130[j]	56	0.0	10.7	64.3	0.0	16.1	0.0	8.9	0.0	0.0	0.0
Little Salmon R.	368	188	0.0	4.3	19.7	0.0	40.4	1.1	31.4	2.1	0.0	1.1
Big Salmon River	765	102	0.0	2.0	7.8	0.0	38.2	0.0	45.1	2.9	0.0	3.9
Nisutlin River	482	18	0.0	0.0	22.2	0.0	0.0	5.6	5.6	50.0	0.0	16.7
Takhini River	225	61	0.0	0.0	21.3	0.0	9.8	11.5	3.3	32.8	0.0	21.3

[a] All samples collected from carcasses and live spawnouts captured with fish spears, except as noted. Escapement index abundance estimates are peak aerial survey counts except as noted..

[b] Includes East Fork tower count of 1,339 and West Fork aerial survey count of 1,448.

[c] Includes samples from live fish captured with snagging gear and beach seine.

[d] Includes samples from live fish captured with snagging gear.

[e] Includes samples from live fish captured with snagging gear and gill nets.

[f] Mark and recapture population estimate for the section of river from Grange Hall Road to 3 miles up the East Fork.

[g] Includes samples from live fish captured with a direct current electroshocker.

[h] Mark and recapture population estimate.

[i] Turbid water precludes aerial surveys in this portion of the river.

[j] DFO foot survey.

Table 2. Classification accuracies of linear discriminant run-of-origin models for age-1.3, -1.4, and -1.5 Yukon River chinook salmon, 1988.

Age 1.3

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	184	0.837	0.054	0.109
Middle	103	0.049	0.621	0.330
Upper	164	0.213	0.311	0.476

Mean Classification Accuracy: 0.645
Variables in analysis: 67, 28, 65, 75, 14.

Age 1.4

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	76	0.750	0.013	0.237
Middle	237	0.054	0.729	0.217
Upper	193	0.187	0.321	0.492

Mean Classification Accuracy: 0.657
Variables in analysis: 2, 67, 62, 13, 29.

Age 1.5

Region of Origin	Sample Size	Classified Region of Origin: Lower	Middle	Upper
Lower	23	0.957	0.000	0.043
Middle	96	0.094	0.688	0.219
Upper	141	0.199	0.312	0.489

Mean Classification Accuracy: 0.711
Variables in analysis: 67, 29, 13, 106.

Table 3. Run composition estimates for age-1.3, -1.4, and -1.5 chinook salmon commercial catches in Yukon River District 1, 1988.

			Age 1.3				Age 1.4				Age 1.5			
					90% Conf. Int.				90% Conf. Int.				90% Conf. Int.	
Commercial Fishing Period	Dates	Region of Origin	Sample Size	Prop. of Catch	Lower Bound	Upper Bound	Sample Size	Prop. of Catch	Lower Bound	Upper Bound	Sample Size	Prop. of Catch	Lower Bound	Upper Bound
Prior to Season[a]	5/27-6/8	Lower	33	0.449	0.117	0.781	53	0.265	0.002	0.527	39	0.011	-0.174	0.195
		Middle		0.053	-0.491	0.597		0.242	-0.124	0.607		0.000	0.000	0.000
		Upper		0.498	-0.253	1.248		0.494	-0.036	1.024		0.989	0.805	1.174
1[b]	6/9-10	Lower	77	0.292	0.074	0.509	49	0.625	0.445	0.806	53	0.056	-0.105	0.218
		Middle		0.034	-0.352	0.421		0.375	0.194	0.555		0.321	-0.075	0.718
		Upper		0.674	0.148	1.201		0.000	0.000	0.000		0.623	0.160	1.085
2[c]	6/13-14	Lower	53	0.265	0.002	0.528	108	0.469	0.267	0.670	153	0.000	0.000	0.000
		Middle		0.007	-0.461	0.476		0.110	-0.120	0.339		0.000	0.000	0.000
		Upper		0.728	0.088	1.368		0.422	0.053	0.791		1.000	1.000	1.000
3[b]	6/15	Lower	11	0.541	0.020	1.063	7	0.501	-0.260	1.262	d			
		Middle		0.000	0.000	0.000		0.287	-0.624	1.198				
		Upper		0.459	-0.063	0.980		0.212	-1.166	1.590				
4[c]	6/16-17	Lower	61	0.236	0.025	0.448	119	0.535	0.368	0.702	93	0.000	0.000	0.000
		Middle		0.000	0.000	0.000		0.000	0.000	0.000		0.000	0.000	0.000
		Upper		0.764	0.552	0.975		0.465	0.298	0.632		1.000	1.000	1.000
5[c]	6/20-21	Lower	60	0.275	0.058	0.491	108	0.590	0.390	0.789	100	0.000	0.000	0.000
		Middle		0.000	0.000	0.000		0.200	-0.020	0.419		0.389	0.106	0.673
		Upper		0.725	0.509	0.942		0.211	-0.141	0.563		0.611	0.327	0.894
6[b]	6/23-24	Lower	29	0.713	0.408	1.017	23	0.716	0.285	1.147	13	0.146	-0.218	0.509
		Middle		0.000	0.000	0.000		0.177	-0.262	0.616		0.000	0.000	0.000
		Upper		0.287	-0.017	0.592		0.107	-0.635	0.849		0.854	0.491	1.218
7[b]	6/27-28	Lower	21	0.506	0.090	0.921	13	0.257	-0.196	0.709	21	0.000	0.000	0.000
		Middle		0.030	-0.623	0.683		0.716	-0.003	1.434		0.179	-0.424	0.782
		Upper		0.464	-0.448	1.377		0.028	-0.908	0.964		0.821	0.218	1.424
8[b]	6/30-7/1	Lower	52	0.635	0.382	0.888	31	0.890	0.741	1.039	31	0.072	-0.147	0.290
		Middle		0.081	-0.305	0.467		0.110	-0.039	0.259		0.260	-0.252	0.772
		Upper		0.284	-0.252	0.820		0.000	0.000	0.000		0.669	0.065	1.272
9[b]	7/4-5	Lower	17	0.566	0.129	1.003	17	0.636	0.340	0.932	18	0.127	-0.181	0.434
		Middle		0.224	-0.518	0.966		0.364	0.068	0.660		0.162	-0.484	0.808
		Upper		0.210	-0.767	1.187		0.000	0.000	0.000		0.711	-0.068	1.490
10[b]	7/7-8	Lower	29	0.685	0.356	1.014	12	0.986	0.297	1.676	d			
		Middle		0.120	-0.385	0.625		0.000	0.000	0.000				
		Upper		0.195	-0.495	0.886		0.014	-0.676	0.703				
11[b]	7/11-12	Lower	16	0.362	-0.066	0.789	10	1.000	1.000	1.000	6	0.182	-0.368	0.733
		Middle		0.000	0.000	0.000		0.000	0.000	0.000		0.000	0.000	0.000
		Upper		0.639	0.211	1.066		0.000	0.000	0.000		0.818	0.267	1.368
12[b]	7/14-15	Lower	9	0.967	0.707	1.227	14	0.825	0.558	1.091	d			
		Middle		0.033	-0.227	0.293		0.175	-0.091	0.442				
		Upper		0.000	0.000	0.000		0.000	0.000	0.000				

[a] Samples from District 1 test fishery collected prior to onset of commercial fishing.
[b] Chum salmon season, 6 in (15.2 cm) maximum mesh size.
[c] Unrestricted mesh size.
[d] Insufficient samples.

Table 4. Run composition estimates for age-1.3, -1.4, and -1.5 chinook salmon commercial catches in Yukon River District 2, 1988.

			Age 1.3				Age 1.4				Age 1.5			
					90% Conf. Int.				90% Conf. Int.				90% Conf. Int.	
Commercial Fishing Period	Dates	Region of Origin	Sample Size	Prop. of Catch	Lower Bound	Upper Bound	Sample Size	Prop. of Catch	Lower Bound	Upper Bound	Sample Size	Prop. of Catch	Lower Bound	Upper Bound
1[a]	6/12-13	Lower	87	0.158	-0.014	0.329	90	0.428	0.231	0.625	63	0.078	-0.085	0.241
		Middle		0.000	0.000	0.000		0.000	0.000	0.000		0.037	-0.308	0.382
		Upper		0.843	0.671	1.014		0.572	0.375	0.769		0.885	0.461	1.308
2[b]	6/15-16	Lower	49	0.286	0.012	0.559	110	0.426	0.251	0.601	131	0.000	0.000	0.000
		Middle		0.023	-0.461	0.508		0.000	0.000	0.000		0.206	-0.038	0.449
		Upper		0.691	0.030	1.352		0.574	0.399	0.749		0.794	0.551	1.038
4[b]	6/17	Lower	55	0.274	0.047	0.501	111	0.438	0.236	0.640	125	0.000	0.000	0.000
		Middle		0.000	0.000	0.000		0.007	-0.217	0.231		0.166	-0.081	0.412
		Upper		0.726	0.499	0.953		0.555	0.182	0.927		0.834	0.588	1.081
5[b]	7/19-20	Lower	51	0.354	0.098	0.609	97	0.587	0.375	0.799	82	0.000	0.000	0.000
		Middle		0.000	0.000	0.000		0.159	-0.071	0.389		0.139	-0.164	0.441
		Upper		0.646	0.406	0.886		0.255	-0.121	0.631		0.861	0.559	1.164

[a] Chum salmon season, 6 in (15.2 cm) maximum mesh size.
[b] Unrestricted mesh size.

Table 5. Classification of age-1.3, -1.4, and -1.5 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 1, 1988.

Commercial Fishing Period	Dates	Region of Origin	Age Group 1.3	1.4	1.5	Total
1[a]	6/9-10	Lower	305	491	37	834
		Middle	36	294	214	544
		Alaska	341	785	251	1,378
		Upper	706	0	415	1,120
		Total	1,047	785	666	2,498
2[b]	6/13-14	Lower	227	971	0	1,199
		Middle	6	227	0	233
		Alaska	234	1,198	0	1,432
		Upper	624	875	2,663	4,162
		Total	858	2,073	2,663	5,594
3[a]	6/15	Lower	298	200	11	509
		Middle	0	115	64	179
		Alaska	298	315	76	688
		Upper	252	85	125	462
		Total	550	400	200 [c]	1,150
4[b]	6/16-17	Lower	713	3,876	0	4,588
		Middle	0	0	0	0
		Alaska	713	3,876	0	4,588
		Upper	2,301	3,367	4,634	10,303
		Total	3,014	7,243	4,634	14,891
5[b]	6/20-21	Lower	595	2,497	0	3,092
		Middle	0	845	1,447	2,292
		Alaska	595	3,342	1,447	5,384
		Upper	1,571	893	2,271	4,735
		Total	2,166	4,235	3,718	10,119
6[a]	6/23-24	Lower	1,771	834	113	2,718
		Middle	0	206	0	206
		Alaska	1,771	1,040	113	2,924
		Upper	713	124	663	1,501
		Total	2,484	1,165	776	4,425
7[a]	6/27-28	Lower	493	105	0	598
		Middle	29	293	101	424
		Alaska	522	399	101	1,021
		Upper	452	11	463	927
		Total	974	410	564	1,948

-Continued-

Table 5. (Page 2 of 2).

Commercial Fishing Period	Dates	Region of Origin	Age Group 1.3	1.4	1.5	Total
8[a]	6/30-7/1	Lower	1,211	776	51	2,039
		Middle	154	96	185	434
		Alaska	1,366	872	236	2,473
		Upper	541	0	475	1,017
		Total	1,907	872	711	3,490
9[a]	7/4-5	Lower	290	198	37	525
		Middle	115	113	48	276
		Alaska	405	311	85	800
		Upper	107	0	208	316
		Total	512	311	293	1,116
10[a]	7/7-8	Lower	168	100	8	276
		Middle	29	0	8	38
		Alaska	198	100	16	314
		Upper	48	1	42	91
		Total	246	101	58 [d]	405
11[a]	7/11-12	Lower	43	45	8	96
		Middle	0	0	0	0
		Alaska	43	45	8	96
		Upper	75	0	37	112
		Total	118	45	45	208
12-17[a]	7/14-8/30	Lower	63	82	5	150
		Middle	2	18	5	25
		Alaska	65	100	10	175
		Upper	0	0	25	25
		Total	65	100	35 [d]	200
District 1 Season Total		Lower	6,176	10,176	271	16,623
		Middle	372	2,207	2,072	4,651
		Alaska	6,548	12,383	2,342	21,273
		Upper	7,393	5,357	12,021	24,771
		Total	13,942	17,736	14,363	46,041

[a] Chum salmon season, 6 in (15.2 cm) maximum mesh size.
[b] Unrestricted mesh size.
[c] Run composition estimated from samples collected during commercial fishing period 1 due to insufficient samples.
[d] Run composition estimated from samples collected during commercial fishing periods 9 and 11 due to insufficient samples.

Table 6. Classification of age-1.3, -1.4, and -1.5 chinook salmon catches by run and fishing period for the commercial fishery in Yukon River District 2, 1988.

Commercial Fishing Period	Dates	Region of Origin	Age Group 1.3	1.4	1.5	Total
1[a]	6/12-13	Lower	79	204	26	309
		Middle	0	0	12	12
		Alaska	79	204	38	321
		Upper	420	274	291	985
		Total	499	478	329	1,306
2[b]	6/15-16	Lower	123	425	0	549
		Middle	10	0	228	238
		Alaska	134	425	228	787
		Upper	298	573	882	1,753
		Total	432	998	1,110	2,540
3[a,c]	6/17	Lower	40	102	13	155
		Middle	0	0	6	6
		Alaska	40	102	19	161
		Upper	212	137	146	495
		Total	252	239	165	656
4[b]	6/19-20	Lower	425	1,454	0	1,879
		Middle	0	24	610	633
		Alaska	425	1,477	610	2,512
		Upper	1,125	1,840	3,070	6,035
		Total	1,550	3,317	3,680	8,547
5[b]	6/22-23	Lower	592	1,932	0	2,524
		Middle	0	523	353	876
		Alaska	592	2,455	353	3,400
		Upper	1,081	839	2,196	4,116
		Total	1,673	3,293	2,549	7,515
6-16[a,d]	6/26-8/31	Lower	2,252	1,253	58	3,563
		Middle	160	424	469	1,053
		Alaska	2,412	1,678	527	4,616
		Upper	1,705	278	1,093	3,077
		Total	4,117	1,956	1,620	7,693
District 2 Season Total		Lower	3,510	5,370	97	8,977
		Middle	170	971	1,678	2,819
		Alaska	3,681	6,341	1,775	11,797
		Upper	4,842	3,940	7,678	16,461
		Total	8,522	10,281	9,453	28,256

[a] Chum salmon season, 6 in (15.2 cm) maximum mesh size.
[b] Unrestricted mesh size.
[c] Run composition estimated from District 2 commercial fishing period 1 samples.
[d] Run composition estimated from District 1 catch samples collected during commercial fishing periods 6-12.

Table 7. Total catch by age class and run of chinook salmon from Yukon River Districts 1, 2, 3, 4, 5, 6, and Yukon Territory commercial and subsistence catches, 1988.

			Brood Year and Age Group										
			1985	1984	1983		1982		1981		1980		
District	Fishery	Run of Origin	1.1	1.2	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5	Total
1	Commercial Gill Net	Lower	0	7,209	6,176	114	10,176	33	271	6	44	0	24,029
		Middle	0	554	372	7	2,207	0	2,072	1	0	4	5,216
		Alaska	0	7,763	6,548	121	12,383	33	2,343	7	44	4	29,245
		Upper	0	1,730	7,393	0	5,357	221	12,021	643	0	506	27,872
		Total	0	9,493	13,942	121	17,733	254	14,362	650	44	510	57,109
	Subsistence Gill Net[a]	Lower	0	507	435	8	716	2	19	0	3	0	1,691
		Middle	0	39	26	0	155	0	146	0	0	0	367
		Alaska	0	546	461	9	872	2	165	0	3	0	2,059
		Upper	0	122	520	0	377	16	847	45	0	36	1,963
		Total	0	668	981	9	1,248	18	1,012	46	3	36	4,020
2	Commercial Gill Net	Lower	0	4,663	3,510	27	5,370	22	97	2	14	0	13,704
		Middle	0	288	170	1	971	0	1,678	1	0	1	3,110
		Alaska	0	4,951	3,680	28	6,341	22	1,775	2	14	1	16,814
		Upper	0	1,290	4,842	0	3,940	206	7,678	296	0	121	18,373
		Total	0	6,241	8,522	28	10,281	228	9,453	298	14	122	35,188
	Subsistence Gill Net[b]	Lower	0	507	381	3	583	2	11	0	1	0	1,489
		Middle	0	31	18	0	105	0	182	0	0	0	338
		Alaska	0	538	400	3	689	2	193	0	1	0	1,826
		Upper	0	140	526	0	428	22	834	32	0	13	1,996
		Total	0	678	926	3	1,117	25	1,027	32	1	13	3,823
3	Commercial Gill Net[b]	Lower	0	234	176	1	270	1	5	0	1	0	688
		Middle	0	14	9	0	49	0	84	0	0	0	156
		Alaska	0	249	185	1	318	1	89	0	1	0	844
		Upper	0	65	243	0	198	10	386	15	0	6	923
		Total	0	313	428	1	516	11	475	15	1	6	1,767
	Subsistence Gill Net[b]	Lower	0	589	443	3	678	3	12	0	2	0	1,730
		Middle	0	36	21	0	123	0	212	0	0	0	393
		Alaska	0	625	465	3	801	3	224	0	2	0	2,123
		Upper	0	163	611	0	497	26	969	37	0	15	2,320
		Total	0	788	1,076	3	1,298	29	1,194	38	2	15	4,443
4	[c,d]	Lower	30	421	660	23	1,150	8	499	1	35	0	2,829
		Middle	75	248	519	12	1,425	18	1,101	1	0	0	3,399
		Alaska	105	670	1,179	35	2,576	26	1,600	2	35	0	6,228
		Upper	0	383	962	0	2,409	114	2,367	68	0	246	6,549
		Total	105	1,053	2,141	35	4,985	140	3,967	70	35	246	12,778
5	Gill Net[c,e]	Upper	0	375	1,876	27	4,180	27	7,985	429	54	375	15,326
	Fish Wheel[c,f]	Upper	40	2,165	3,007	27	1,082	107	775	94	13	13	7,323
6	Gill Net[c,g]	Middle	0	479	96	0	192	0	96	0	0	0	863
	Fish Wheel[c,h]	Middle	72	1,492	1,492	0	1,690	0	575	0	18	0	5,340
Yukon Territory	Commercial Gill Net	Upper	0	463	1,983	33	5,056	231	4,296	727	33	397	13,217
	Subsistence[i] Gill Net	Upper	0	265	1,134	19	2,892	132	2,457	416	19	227	7,560
TOTAL HARVEST		Lower	30	14,130	11,781	180	18,944	72	914	9	100	0	46,161
		Middle	147	3,182	2,724	21	6,917	18	6,147	3	18	5	19,183
		Alaska	177	17,313	14,505	201	25,861	90	7,060	13	118	5	65,344
		Upper	40	7,161	23,098	106	26,417	1,112	40,615	2,802	119	1,955	103,421
		Total	217	24,474	37,604	306	52,270	1,203	47,672	2,814	237	1,961	168,757

[a] Run composition based on season total District 1 commercial catch samples.
[b] Run composition based on season total District 2 commercial catch samples.
[c] Commercial and subsistence catches pooled.
[d] Gill net and fish wheel catches pooled. Commercial catch = 3,159 fish. Subsistence catch = 9,619 fish, including Koyukuk River catch (484 fish) estimated to be entirely of middle Yukon origin.
[e] Commercial catch = 2,325. Subsistence catch = 13,001.
[f] Commercial catch = 1,111. Subsistence catch = 6,212.
[g] Commercial catch = 106. Subsistence catch = 656.
[h] Commercial catch = 757. Subsistence catch = 4,684.
[i] Run and age composition based on Yukon Territory commercial catch samples.

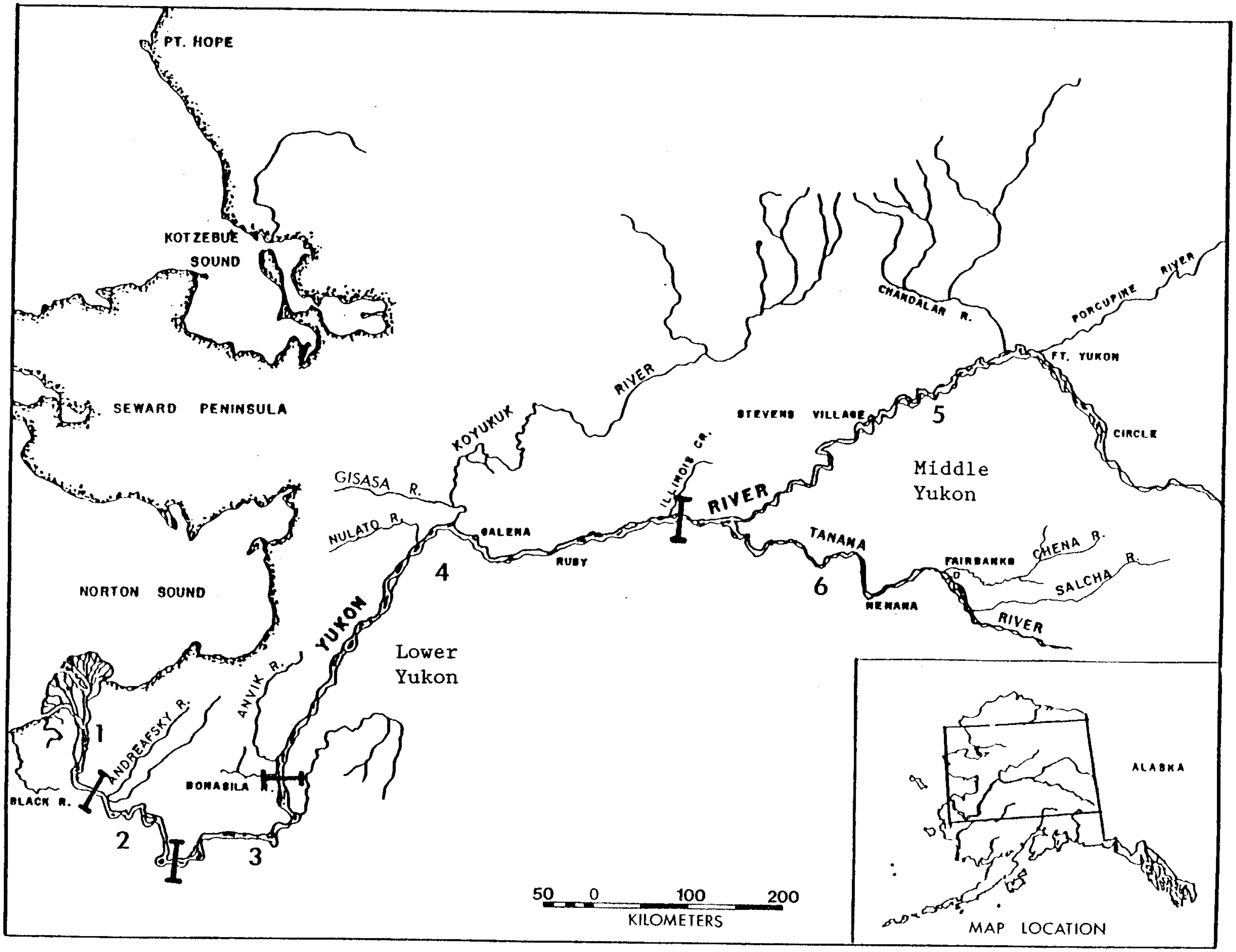

Figure 1. Alaskan portion of the Yukon River, showing fishing district boundaries.

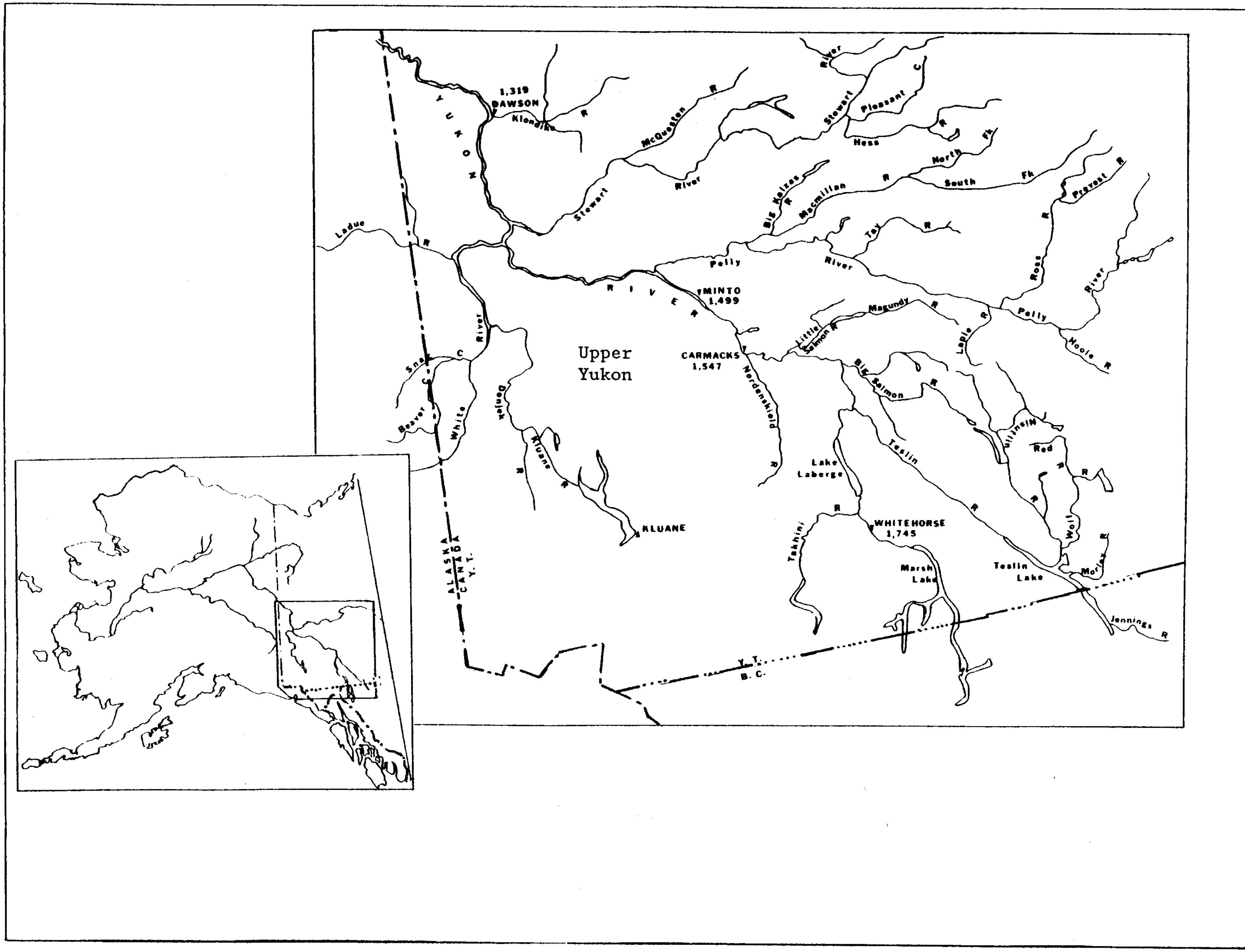

Figure 2. Canadian portion of the Yukon River.

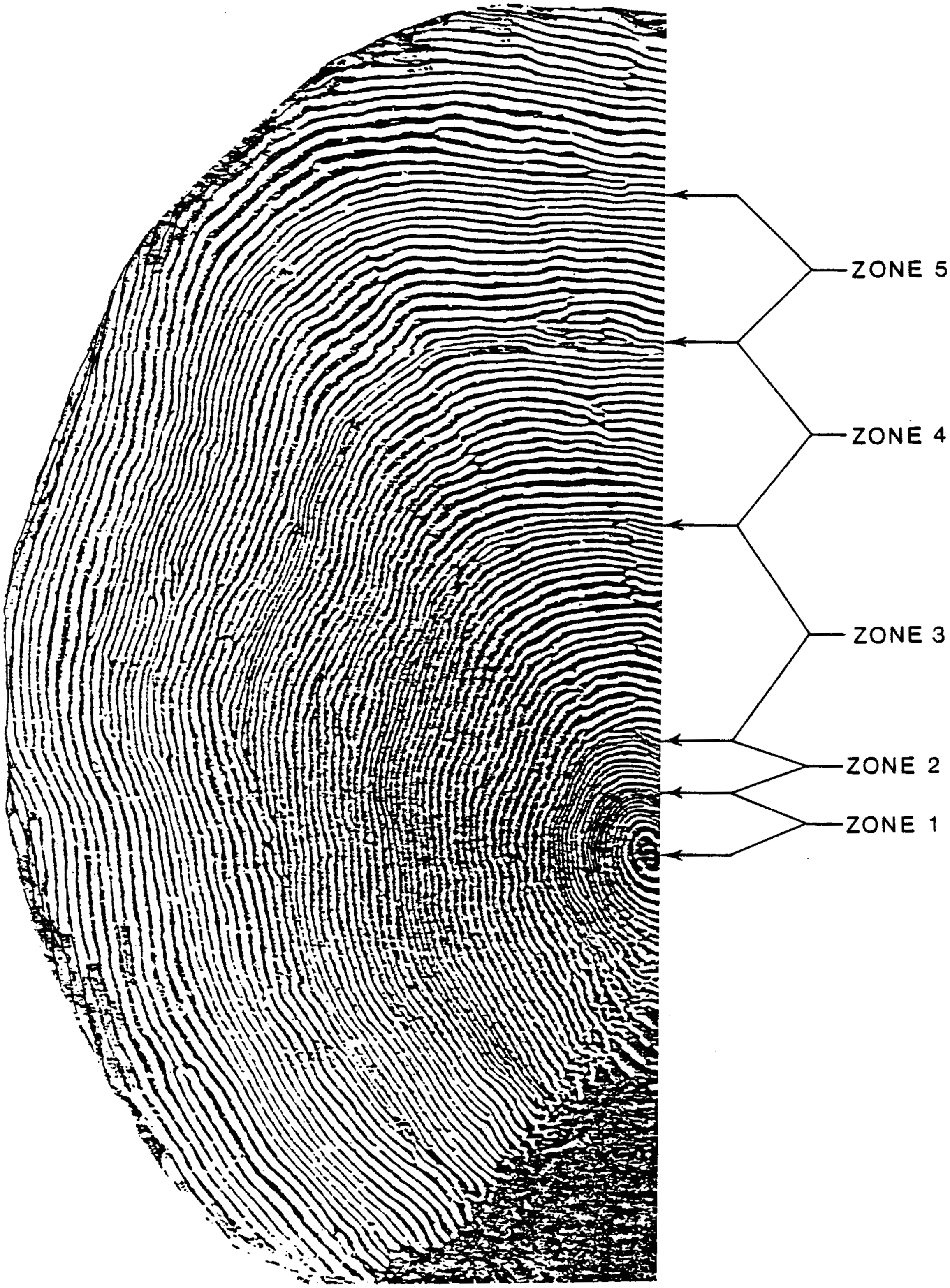

Figure 3. Age-1.4 chinook salmon scale showing zones measured for linear discriminant analysis.

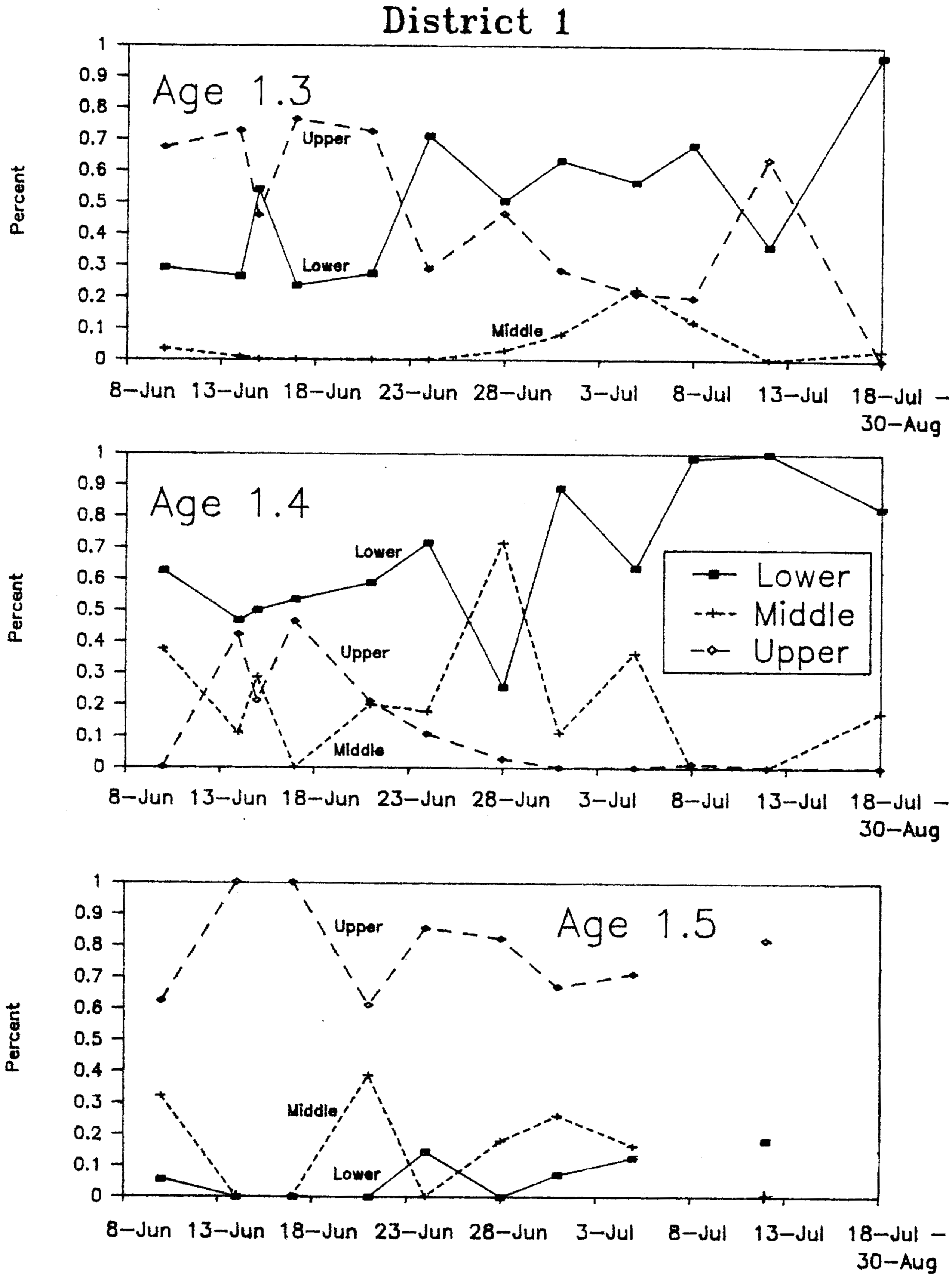

Figure 4. Weekly run composition estimates from scale patterns analysis of age-1.3, -1.4, and -1.5 chinook salmon, Yukon River District 1, 1988.

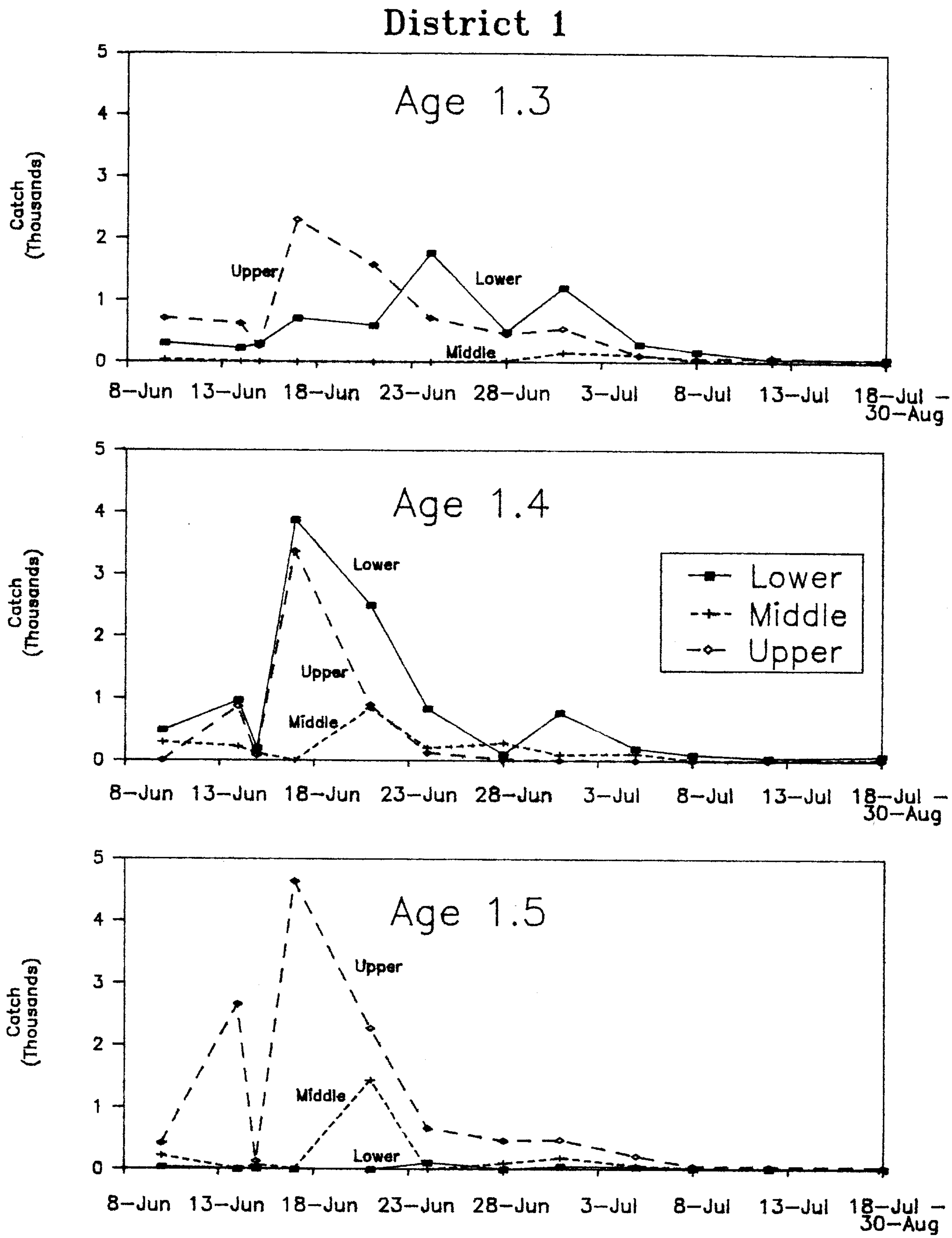

Figure 5. Catches by run estimated from scale patterns analysis of age-1.3, -1.4, and -1.5 chinook salmon, Yukon River District 1, 1988.

APPENDICES

Appendix A. Scale variables screened for linear discriminant function analysis of age-1.3, -1.4, and -1.5 Yukon River chinook salmon.

Variable	1st Freshwater Annular Zone
1	Number of circuli (NC1FW)[a]
2	Width of zone (S1FW)[b]
3 (16)	Distance, scale focus (C0) to circulus 2 (C2)
4	Distance, C0-C4
5 (18)	Distance, C0-C6
6	Distance, C0-C8
7 (20)	Distance, C2-C4
8	Distance, C2-C6
9 (22)	Distance, C2-C8
10	Distance, C4-C6
11 (24)	Distance, C4-C8
12	Distance, C(NC1FW -4) to end of zone
13 (26)	Distance, C(NC1FW -2) to end of zone
14	Distance, C2 to end of zone
15	Distance, C4 to end of zone
16-26	Relative widths, (variables 3-13)/S1FW
27	Average interval between circuli, S1FW/NC1FW
28	Number of circuli in first 3/4 of zone
29	Maximum distance between 2 consecutive circuli
30	Relative width, (variable 29)/S1FW
Variable	**Freshwater Plus Growth**
61	Number of circuli (NCPG)[c]
62	Width of zone (SPGZ)[d]
Variable	**All Freshwater Zones**
65	Total number of freshwater circuli (NC1FW+NCPG)
66	Total width of freshwater zone (S1FW+SPGZ)
67	Relative width, S1FW/(S1FW+SPGZ)

- Continued -

Appendix A. (Page 2 of 2).

Variable	1st Marine Annular Zone
70	Number of circuli (NC1OZ)[e]
71	Width of zone (S1OZ)[f]
72 (90)	Distance, end of freshwater growth (EFW) to C3
73	Distance, EFW-C6
74 (92)	Distance, EFW-C9
75	Distance, EFW-C12
76 (94)	Distance, EFW-C15
77	Distance, C3-C6
78 (96)	Distance, C3-C9
79	Distance, C3-C12
80 (98)	Distance, C3-C15
81	Distance, C6-C9
82 (100)	Distance, C6-C12
83	Distance, C6-C15
84 (102)	Distance, C(NC1OZ -6) to end of zone
85	Distance, C(NC1OZ -3) to end of zone
86 (104)	Distance, C3 to end of zone
87	Distance, C9 to end of zone
88	Distance, C15 to end of zone
90-104	Relative widths, (variables 73-86)/S1OZ
105	Average interval between circuli, S1OZ/NC1OZ
106	Number of circuli in first 1/2 of zone
107	Maximum distance between 2 consecutive circuli
108	Relative width, (variable 107)/S1OZ

Variable	All Marine Zones
109	Width of 2nd marine zone, (S2OZ)
110	Width of 3nd marine zone, (S3OZ)
111	Total width of marine zones (S1OZ+S2OZ+S3OZ)
112	Relative width, S1OZ/(S1OZ+S2OZ+S3OZ)
113	Relative width, S2OZ/(S1OZ+S2OZ+S3OZ)

[a] Number of circuli, 1st freshwater zone.
[b] Size (width) 1st freshwater zone.
[c] Number of circuli, plus growth zone.
[d] Size (width) plus growth zone.
[e] Number of circuli, 1st ocean zone.
[f] Size (width) 1st ocean zone.

Appendix B. Group means, standard errors and one-way analysis of variance F-test for scale variables selected for use in linear discriminant models of age-1.3, -1.4, and -1.5 Yukon River chinook salmon runs, 1988.

		Lower		Middle		Upper		
Growth Zone	Variable	Mean	SE	Mean	SE	Mean	SE	F-value
Age-1.3								
1st FW Annular	14	79.42	1.05	56.87	1.34	61.54	1.11	110.18
	28	5.99	0.09	4.58	0.11	4.52	0.09	81.39
Total FW Growth	65	13.38	0.14	14.36	0.22	13.95	0.19	7.08
	67	0.85	<0.01	0.64	<0.01	0.70	<0.01	179.10
1st Ocean Ann.	75	192.40	1.48	208.52	2.03	210.31	1.89	34.23
Age-1.4								
1st FW Annular	2	131.00	2.23	98.36	0.99	110.07	1.09	123.60
	13	14.18	0.32	14.02	0.19	13.07	0.20	7.34
	29	16.86	0.35	14.40	0.18	15.99	0.20	29.90
FW Plus Growth	62	32.66	1.60	64.12	1.29	50.30	1.81	67.23
Total FW Growth	67	0.80	<0.01	0.61	<0.01	0.70	<0.01	111.39
Age-1.5								
1st FW Annular	13	13.00	0.56	13.56	0.26	12.90	0.23	1.85
	29	17.30	0.47	13.95	0.28	15.79	0.28	16.28
Total FW Growth	67	0.84	0.01	0.63	0.01	0.67	0.01	36.49
1st Ocean Ann.	106	14.91	0.28	13.49	0.16	13.21	0.14	11.34

Appendix C. Group means, standard errors, and one-way analysis of variance F-test for the number of circuli and incremental distance of salmon scale growth zone measurements from age-1.3, -1.4, and -1.5 Yukon River chinook salmon runs, 1988.

		Lower		Middle		Upper		
Growth Zone	Variable	Mean	SE	Mean	SE	Mean	SE	F-Value
Age 1.3								
1st FW Annular	No. Circ.	10.75	0.118	8.64	0.142	8.92	0.116	88.79
	Distance	130.97	1.139	105.91	1.669	114.14	1.289	91.38
FW Plus Growth	No. Circ.	2.64	0.095	5.72	0.176	5.03	0.175	123.84
	Distance	24.33	1.005	60.02	1.951	51.84	2.059	127.54
1st Ocean Annular	No. Circ.	27.21	0.175	26.39	0.289	26.58	0.282	3.10
	Distance	494.05	3.613	486.11	6.046	492.34	5.160	0.63
2nd Ocean Annular	Distance	443.26	4.896	462.39	9.363	443.08	7.209	2.13
Age 1.4								
1st FW Annular	No. Circ.	10.32	0.220	8.08	0.092	8.81	0.103	64.34
	Distance	131.00	2.233	98.36	0.994	110.07	1.094	123.60
FW Plus Growth	No. Circ.	3.42	0.156	6.31	0.121	4.99	0.163	68.45
	Distance	32.66	1.602	64.12	1.288	50.30	1.811	67.63
1st Ocean Annular	No. Circ.	26.40	0.331	25.46	0.179	26.10	0.257	3.52
	Distance	495.40	6.398	471.14	3.682	483.71	4.316	5.86
2nd Ocean Annular	Distance	396.74	10.267	383.35	4.708	372.38	4.854	3.18
3rd Ocean Annular	Distance	422.51	8.646	421.61	3.909	410.73	4.035	1.94
Age 1.5								
1st FW Annular	No. Circ.	9.65	0.391	7.98	0.155	8.49	0.117	12.29
	Distance	122.70	4.091	92.70	1.822	103.50	1.387	30.67
FW Plus Growth	No. Circ.	2.61	0.196	5.70	0.184	5.29	0.162	27.29
	Distance	24.00	2.237	55.22	1.974	52.53	1.718	25.09
1st Ocean Annular	No. Circ.	28.26	0.504	26.37	0.292	25.94	0.226	7.18
	Distance	493.61	10.123	455.99	5.685	462.49	4.390	4.65
2nd Ocean Annular	Distance	361.83	10.087	345.97	6.240	348.32	4.491	0.75
3rd Ocean Annular	Distance	357.78	10.964	369.85	5.708	357.45	3.896	1.81